TECHNICAL APPENDIX FROM

VITAL STATISTICS OF THE UNITED STATES

2004

NATALITY

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Introduction

This Technical Appendix, published by the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS), is reprinted from Vital Statistics of the United States, 2004, Volume I, Natality (1). Reference will be made to the 1999 Technical Appendix for historical context and a more lengthy discussion of some variables, as well as the quality and completeness of the birth data (2). This report supplements the Technical Notes section of "Births: Final data for 2004" (3) and is recommended for use with the public-use file for 2004 births, available on CD-ROM from NCHS (4), and the tabulated data of Vital Statistics of the United States, 2004 Volume I, Natality (1)**,** in addition to the Internet publication of tables for variables not included in the 2004 natality report.

Definition of Live Birth

Every product of conception that gives a sign of life after birth, regardless of the length of the pregnancy, is considered a live birth. This concept is included in the definition set forth by the World Health Organization in 1950 (5). A slightly expanded definition of live birth was recommended by the 1992 revision of the Model State Vital Statistics Act and Regulations (6), based on recommendations of a 1988 working group formed by the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists (7) and is consistent with that currently used by the WHO in the ICD–10 (8) and the United Nations**:**

> "Live birth" means the complete expulsion or extraction from its mother of a product of human conception, irrespective of the duration of pregnancy, which, after such expulsion or extraction, breathes, or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached. Heartbeats are to be distinguished from transient cardiac contractions; respirations are to be distinguished from fleeting respiratory efforts or gasps.

This definition distinguishes in precise terms a live birth from a fetal death (9,10). Forty-eight registration areas use definitions of live births similar to this definition; five areas use a shortened definition; four have no formal definition of live birth. (9). All states require the reporting of live births regardless of length of gestation or birth weight.

History of Birth-Registration Area

Currently the birth-registration system of the United States includes the 50 states, the District of Columbia, the independent registration area of New York City, and Puerto Rico, the U.S. Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands (referred to as Northern Marianas). However, in the statistical tabulations, “United States” refers only to the aggregate of the 50 states (including New York City) and the District of Columbia. Information on the history and development of the birth-registration area is available elsewhere (2,11).

Sources of Data

Natality statistics

Since 1985, natality statistics for all states and the District of Columbia have been based on information from the total file of records. The information is received on electronic files consisting of individual records processed by the states, the District of Columbia, New York City, Puerto Rico, the Virgin Islands, American Samoa, and the Northern Marianas. NCHS receives these files from the registration offices of all states, the two cities and four territories through the Vital Statistics Cooperative Program. Information for Guam is obtained from paper copies of original birth certificates, which are coded and keyed by NCHS. Data from American Samoa first became available in 1997 and from the Northern Marianas in 1998.

U.S. natality data are limited to births occurring within the United States, including those occurring to U.S. residents and nonresidents. Births to nonresidents of the United States have been excluded from all tabulations by place of residence beginning in 1970 (for further discussion see Classification by occurrence and residence). Births occurring to U.S. citizens outside the United States are not included in the natality file. Data for Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Northern

Marianas are limited to births registered in these areas.

Standard Certificates of Live Birth

The U.S. Standard Certificate of Live Birth, issued by the U.S. Department of Health and Human Services, has served for many years as the principal means for attaining uniformity in the content of the documents used to collect information on births in the United States. The U.S. Standard Certificate of Live Birth is revised every 10–15 years. Most state certificates conform closely in content to the standard certificate, but are modified to the extent required by the particular state's needs or by special provisions of the state's vital statistics law.

1989 revision—Effective January 1, 1989, a revised U.S. Standard Certificate of Live Birth (Figure 4-A) replaced the 1978 revision. This revision provided a wide variety of new information on maternal and infant health characteristics, representing a significant departure from previous versions in both content and format. The most significant format change was the use of check boxes to obtain detailed medical and health information about the mother and child. Details of the nature and content of the 1989 revision are available elsewhere (2,11).

2003 revision—In 2003, a revised U.S. Standard Certificate of Live Birth was adopted, with initial implementation in two states (Pennsylvania and Washington). Five states, Idaho, Kentucky, New York (excluding New York City), South Carolina, and Tennessee implemented the revised birth certificate as of January 1, 2004. Two additional states, Florida and New Hampshire, implemented the revised birth certificate in 2004, but after January 1. The nine revised states represent 20 percent of all 2004 births; the seven states which implemented the revision as of January 1, 2004 represent 14 percent of all 2004 births. Full implementation in all states of the revised certificate will be phased in over several years. There are numerous new items on the 2003 certificate, and old items have been modified. Examples of modified items include multiple race, educational attainment, smoking during pregnancy, and prenatal care. A few examples of new check box categories for old items are infertility treatment, NICU admission, and trial of labor prior to a cesarean delivery. The process of the 2003 revision and the revision contents are described elsewhere. (12,13).

A key aspect of the 2003 revision of the United States standard certificate has been the re-engineering of the data collection and transmission system. The intent of the re-engineering is to improve data quality, speed of data collection and transmission, and to enhance the standardization of data (14). To encourage collection of data from the best sources, two worksheets have been developed: the Mother's Worksheet and the Facility Worksheet. In the Mother's Worksheet, data are directly obtained from the mother and include such data as race, Hispanic origin, and educational attainment. In the Facility Worksheet, data are obtained directly from medical records of the mother and infant for items such as date of last normal menses, risk factors, and method of delivery. To assist hospital staff in completing the Facility Worksheet, a comprehensive instruction manual was developed: *Guide to Completing the Facility Worksheets for the Certificate of Live Birth and Report of Fetal Death (2003 Revision)* (15).

The medical and health check boxes—Both the 1989 and 2003 Standard Certificates of Live Birth use a check box format for collecting much of the medical and health information available on the birth certificate. This information includes items on pregnancy or medical risk factors, method of delivery, obstetric procedures, characteristics of labor or delivery, abnormal conditions or congenital anomalies of the newborn. However, a number of individual check box items included on the 1989 certificate were dropped from the revised certificate in 2003 (such as Rh sensitization, incompetent cervix, and amniocentesis). In addition, specifications for some check box items were modified for the 2003 revision, resulting in data which are not comparable across revisions (for example: premature rupture of membranes and prolonged labor). See Table A and 2004 file documentation for reporting areas (4).

The report "Births: Final Data for 2004" includes items which are reported in both the 1989 and the 2003 Standard Certificate of Live Birth. Data items exclusive to either the 1989 (e.g. maternal anemia, ultrasound, and alcohol use) or the 2003 birth certificate revision (e.g. such as the use of infertility treatment and NICU admission) are not shown. Supplemental 2004 tables for data exclusive to the 1989 revision are available on the NCHS website (www.cdc.gov/nchs). A forthcoming report will present selected information exclusive to the 2003 revision.

The 2004 Natality Data File

The 2004 data file includes data items which are comparable between the 1989 and 2003 revisions of the U.S. Standard Certificate of Live Birth. The file also includes all data which are exclusive to the 1989 revision, such as febrile infant and cord prolapse. Additionally, the 2004 file also includes new check box response categories for selected items, such as number of previous cesarean deliveries and surfactants to newborn. Certain new data items exclusive to the 2003 revised certificate are not available on the file:

- date of last prenatal care visit
- 10-minute Apgar score
- mother's height
- infections present (5 items)
- whether infant was alive at time of report
- matching number for plural births
- source of payment for delivery
- WIC food receipt
- maternal morbidity (7 items)
- whether infant was breastfed at discharge

The 1989 certificate was used in 41 states, the District of Columbia, and the territories for *all* of 2004. Seven states used the 2003 certificate throughout the 2004 data year: Idaho, Kentucky, New York (excluding New York City), Pennsylvania, South Carolina, Tennessee and Washington. Florida used the 1989 revision during January and February, 2004 and implemented the 2003 revision on March 1; New Hampshire used the 1989 revision until July 19 and implemented the 2003 revision on July 20.

One of the principal values of vital statistics data is realized through the presentation of rates that are computed by relating the vital events of a class to the population of a similarly defined class. Vital statistics and population statistics, therefore, must be tabulated in comparable groups. Even when the variables common to both, such as geographic area, age, race, and sex, have been similarly classified and tabulated, significant discrepancies may result from differences between the enumeration method of obtaining population data and the registration method of obtaining vital statistics data.

The general rules used to classify characteristics of live births are set forth in two NCHS manuals (16,17). The instruction materials are for states to use in coding the data items; they do not include NCHS recodes. Therefore, the file layout (4) is a better source of information on the code structure because it provides the exact codes, recodes and reporting flags that are available. Classification of certain important items is discussed in the following pages. Information on the completeness of reporting of birth certificate data is shown in Table A, which presents a listing of items and the percentage of records that were not stated for each state, Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Northern Marianas.

Occurrence and residence

In tabulations by place of residence, births occurring within the United States to U.S. citizens and to resident aliens are allocated to the usual place of residence of the mother in the United States, as reported on the birth certificate. Beginning in 1970, births to nonresidents of the United States occurring in the United States are excluded from these tabulations. Births to U.S. residents occurring outside this country are not included in tabulations by place of residence.

The total count of births for the United States by place of residence and by place of occurrence will not be identical. Births to nonresidents of the United States are included in data by place of occurrence but excluded from data by place of residence, as previously indicated. See Table B for the number of births by residence and occurrence for the 50 states and the District of Columbia for 2004.

Residence error—A nationwide test of birth-registration completeness in 1950 provided measures of residence error for natality statistics. According to the 1950 test (which has not been repeated), errors in residence reporting for the country as a whole tend to overstate the number of births to residents of urban areas and to understate the number of births to residents of other areas (18). Recent experience suggests that this is still a concern based on anecdotal evidence from the states. This tendency has assumed special importance because of a concomitant development—the increased utilization of hospitals in cities by residents of nearby places—with the result that a number of births are erroneously reported as having occurred to residents of urban areas. Another factor that contributes to this overstatement of urban births is the customary practice of using city addresses for persons living outside the city limits. Residence error should be taken into consideration in interpreting data for small areas and for cities. Both birth and infant mortality patterns can be affected.

Incomplete residence—Beginning in 1973, where only the state of residence is reported with no city or county specified and the state named is different from the state of occurrence, the birth is allocated to the largest city of the state of residence. Before 1973, such births were classified according to the exact place of occurrence.

Geographic classification

The rules followed in the classification of geographic areas for live births are contained in the instruction manual mentioned previously. The geographic code structure for the 2004 file is given in two manuals, Vital Records Geographic Classification, 2003, and Vital Records Geographic Classification, 2004. Federal Information Processing Standards (FIPS). *NCHS Instruction Manual*, *Part 8*, (17) and (19)**.** The geographic code structure on the 2004 file is based on results of the 2000 census of population.

United States—In the statistical tabulations, "United States" refers only to the aggregate of the 50 states and the District of Columbia. Alaska has been included in the U.S. tabulations since 1959 and Hawaii since 1960.

Details of the classification of births for metropolitan statistical areas, metropolitan and non-metropolitan counties, and population size groups for cities and urban places are presented elsewhere (2).

Places with a population of less than 100,000 are not separately identified on the public-use file because of confidentiality limitations.

Demographic Characteristics

Hispanic origin, and race

Hispanic origin—Hispanic origin and race are reported separately on the birth certificate. Data for Hispanic subgroups are shown in most cases for five specific groups: Mexican, Puerto Rican, Cuban, Central and South American, and "other and unknown Hispanic." In tabulations of birth data by race and Hispanic origin, data for persons of Hispanic origin are not further classified by race because the vast majority of births to Hispanic women in 2004 are reported as white as in previous years. In tabulations of birth data by race only, data for persons of Hispanic origin are included in the data for each race group according to the mother's reported race. In tabulations that include Hispanic origin, data for non-Hispanic persons are classified according to the race of the mother because there are substantial differences in fertility and maternal and infant health between Hispanic and non-Hispanic white women. A recode variable is available that provides cross tabulations of race by Hispanic origin.

Items asking for the Hispanic origin of the mother and the father have been included on the birth certificates of all states and the District of Columbia, the Virgin Islands, and Guam since 1993 (3). Puerto Rico, American Samoa, and the Northern Marianas do not collect this information. In addition, Florida (for births occurring from March 1, 2004 only), Idaho, Kentucky, New Hampshire (for births occurring as of July 19, 2004 only), New York State (excluding New York City), Pennsylvania, South Carolina, Tennessee, and Washington, which used the 2003 revision of the U.S. Standard Certificate of Live Birth, permitted respondents to select one or more Hispanic origin categories (Figure 4-B). Minnesota, which used the 1989 revised certificate, also allowed reporting of multiple Hispanic groups. These 10 revised states accounted for 13 percent of Hispanic births in the United States in 2004. The percentage of records for which Hispanic origin of the parents was not reported in 2004 is shown by state in Table A.

The new Hispanic origin question asks that the respondent "check the box that best describes whether the mother or father is Spanish/Hispanic/Latina/o." Although only one response is asked for, multiple responses to this item are sometimes given. Therefore, the electronic state birth registration systems are designed to capture multiple responses to this item. If more than one box is checked, or if there is a literal entry and one or more boxes checked, the code for "multiple Hispanic" is applied. These records are classified as "other Hispanic" in NCHS data. The percentage of Hispanic mothers in the 10 revised states reporting more than one Hispanic origin group in 2004 was 1.5 percent.

In computing birth and fertility rates for the Hispanic population, births with origin of mother not stated are included with non-Hispanic births rather than being distributed. Thus, rates for the Hispanic population are underestimates of the true rates (20) to the extent that the births with Hispanic origin of mother not stated (0.8 percent in 2004) were actually to Hispanic mothers. The population with origin not stated was imputed. The effect on the rates is believed to be small.

Single, multiple and "bridged" race of mother and father—In 1997, the Office of Management and Budget (OMB) issued Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity which revised the 1977 Statistical Policy Directive

15, Race and Ethnic Standards for Federal Statistics and Administrative Reporting (21–23). These documents specify guidelines for collection, tabulation, and presentation of race and ethnicity data within the federal statistical system. The 1997 revised standards incorporated two major changes designed to reflect the changing racial profile of the United States. First, the revision increased from four to five the minimum set of categories to be used by federal agencies for identification of race. The 1977 standards required federal agencies to report race-specific tabulations using a minimum set of four single-race categories: American Indian or Alaska Native (AIAN), Asian or Pacific Islander (API), Black, and White. The five categories for race specified in the 1997 standards are: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, and White. The revised standards called for reporting of Asians separately from Native Hawaiians or other Pacific Islanders. Collection of additional detail on race and ethnicity is permitted, as before, so long as the additional categories can be aggregated into the minimum categories. The revised standards also require federal data collection programs to allow respondents to select *one or more race categories*.

For the 2000 decennial census, the U.S. Census Bureau collected race and ethnicity data in accordance with the 1997 revised standards. However, the National Vital Statistics System, which is based on data collected by the states, will not be fully compliant with the new standards until all of the states revise their birth certificates to reflect the new standards. Thus, beginning with the 2000 data year, the numerators (births) for birth rates are incompatible with the denominators (populations) (see Population denominators). In order to compute rates, it is necessary to "bridge" population data for multiple-race persons to single-race categories. This has been done for birth rates by race presented in this report. Once all states revise their birth registration systems to be compliant with the 1997 OMB standards, the use of bridged populations can be discontinued.

For the 2004 data year, multiple races were reported by Florida (for births occurring from March 1, 2004 only), Idaho, Kentucky, New Hampshire (for births occurring from July 19, 2004 only), New York State (excluding New York City), Pennsylvania, South Carolina, Tennessee and Washington, which used the 2003 revision of the U.S. Standard Certificate of Live Birth, as well as by California, Hawaii, Michigan (for births at selected facilities only), Minnesota, Ohio, and Utah, which used the 1989 revision of the U.S. Standard Certificate of Live Birth. These 15 states, which account for 43.0 percent of U.S. births in 2004, reported 1.8 percent of mothers as multiracial, with levels varying from 0.5 percent (New Hampshire) to 34.4 percent (Hawaii). Data from the vital records of the remaining 35 states and the District of Columbia followed the 1977 OMB standards in which a single race is reported (21). In addition, these areas also report the minimum set of four races as stipulated in the 1977 standards (21), compared with the minimum of five races for the 1997 (22) standards.

In order to provide uniformity and comparability of the data during the transition period, before multiple-race data are available for all reporting areas, it is necessary to bridge the responses of those who reported more than one race to a single-race. The bridging procedure for multiple-race mothers and fathers is based on the procedure used to bridge the multiracial population estimates (see Population denominators) (23,24). Multiple-race is imputed to a single race (one of the following: AIAN, API, black, or white) according to the combination of races, Hispanic origin, sex, and age indicated on the birth certificate of the mother or father. The imputation procedure is described in detail elsewhere (25,26).

As noted previously, the bridging procedure imputes multiple-race of mothers to one of the four minimum races stipulated in the 1977 OMB standards, that is, AIAN, API, black, or white. Mothers of a specified Asian or Pacific Islander subgroup (that is, Chinese, Japanese, Hawaiian, or Filipino) in combination with another race (that is, AIAN, black, and/or white) or another API subgroup cannot be imputed to a single API subgroup. API mothers are disproportionately represented in the 15 states reporting multiple-race (54.8 percent in 2004). For both reports: "Births: Final Data for 2003" and "Births: Final Data for 2004," data are not shown for the specified API subgroups because the bridging technique cannot be applied in this detail (3,23,24). However, data for the API subgroups, reported alone or in combination with other races and/or API subgroups, are available in the 2004 natality public-use data file. A forthcoming (27) report describes characteristics of births in 2003 to single and multiple-race women.

Race of mother is reported by 35 states and the District of Columbia in at least eight single-race categories: white, black, American Indian or Alaska Native, Chinese, Japanese, Hawaiian, Filipino, and "other Asian or Pacific Islander" (API). Of these, six states (Illinois, Missouri, New Jersey, Texas, Virginia, and West Virginia) report data on the expanded API subgroups included in the "other API category" (Asian Indian, Korean, Samoan, Vietnamese, Guamanian, and remaining API). Finally, the fifteen states which report multiple-race data (California, Hawaii, Ohio, Pennsylvania, Utah, and Washington) report a minimum of fourteen categories (white, black, American Indian or Alaska Native, Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, other Asian, Hawaiian, Guamanian, Samoan, and other Pacific Islander). For this report, as discussed above, the multiple-race combinations (for example, white and AIAN or black and Chinese) were bridged to one of four broad categories (bridged white, bridged black, bridged AIAN, and bridged API). Detailed data on race (single or multiple) as reported in these 15 states are available from the 2004 natality public use file.

In 2004, race of mother was not reported for 0.9 percent of births. In these cases, if the race of the father was known, the race of the father was assigned to the mother. When information was not available for either parent, the race of the mother was imputed according to the specific race of the mother on the preceding record with a known race of mother. This was necessary for just 0.7 percent of births in 2004.

Beginning with the 1989 data year, NCHS started tabulating its birth data primarily by race of the mother. In 1988 and prior years, births were tabulated by the race of the child, which was determined from the race of the parents as entered on the birth certificate. The reasons for this change are summarized in the 1999 Technical Appendix (2). Trend data by race shown in this report are by race of mother for all years beginning with the 1980 data year. Text references to white births and white mothers or black births and black mothers are used interchangeably.

Age of mother

Beginning in 1989, a "date of birth" item on the birth certificate replaced the "age [at time of this birth]" item. Not all states revised this item, and, therefore, the age of mother either is derived from the reported month and year of birth or coded as stated on the certificate. In 2004, age of mother was reported directly by four states (Nevada, North Dakota, Virginia, and Wyoming) and American Samoa.

From 1964 to 1996, births reported to occur to mothers younger than age 10 or older than age 49 years had age imputed according to the age of mother from the previous record with the same race and total birth order (total of live births and fetal deaths). Beginning in 1997, age of mother is imputed for ages 9 years or under and 55 years and over. A review and verification of unedited birth data for 1996 showed that the vast majority of births reported as occurring to women aged 50 years and older were to women aged 50–54 years. The numbers of births to women aged 50–54 years are too small for computing age-specific birth rates. These births have been included with births to women aged 45–49 years for computing birth rates (2).

Age-specific birth rates are based on populations of women by age, prepared by the U.S. Census Bureau. In census years the decennial census counts are used. In intercensal years, estimates of the population of women by age are published by the U.S. Census Bureau in *Current Population Reports*. The 2000 census of population derived age in completed years as of April 1, 2000 from responses to questions on age at last birthday and month and year of birth, with the latter given preference. In the 1960, 1970, 1980, and 1990 census of population, age was also derived from month and year of birth. Age in completed years was asked in censuses before 1960. This was nearly the equivalent of the former birth certificate question, which the 1950 test of matched birth and census records confirmed by showing a high degree of consistency in reporting age in these two sources (28). More recently, reporting of maternal age on the birth certificate was compared with reporting of age in a survey of women who had recently given birth. Reporting of age was very consistent between the two sources (29).

Median age of mother—Median age is the value that divides an age distribution into two equal parts, one-half of the values being less and one-half being greater. Median ages of mothers for 1960 to the present have been computed from birth rates for 5-year age groups rather than from birth frequencies. This method eliminates the effects of changes in the age composition of the childbearing population over time. Changes in the median ages from year to year can thus be attributed solely to changes in the age–specific birth rates. Trend data on the median age are shown in Table 1–5 of Vital Statistics of the

United States, 2001, Volume 1, Natality (30), which is available on the Internet at**:** http://www.cdc.gov/nchs/datawh/statab/unpubd/natality/natab2001.htm

Not stated age or date of birth of mother—In 2004, age of mother was not reported on 0.02 percent of the records. Beginning in 1964, birth records with date of birth of mother or age of mother not stated have had age imputed according to the age of mother from the previous birth record of the same race and total-birth order (total of fetal deaths and live births). (See *NCHS Instruction Manual*, part 12, page 9) (31). Editing procedures for 1963 and earlier years are described elsewhere (2).

Age of father

Age of father is derived from the reported date of birth or coded as stated on the birth certificate. If the age is under 10 years, it is considered not stated and grouped with those cases for which age is not stated on the certificate. Information on age of father is often missing on birth certificates of children born to unmarried mothers, greatly inflating the number in the "not stated" category in all tabulations by age of father. In computing birth rates by age of father, births tabulated as age of father not stated are distributed in the same proportions as births with known age within each 5-year age classification of the mother. This procedure is followed because, while father's age is missing on 13.6 percent of the birth certificates in 2004, one-quarter of these were on records where the mother is a teenager. This distribution procedure is done separately by race. The resulting distributions are summed to form a composite frequency distribution that is the basis for computing birth rates by age of father. This procedure avoids the distortion in rates that would result if the relationship between age of mother and age of father were disregarded. Births with age of father not stated are distributed only for rates, not for frequency tabulations (3).

Live-birth order and parity

Live-birth order and parity classifications refer to the total number of live births the mother has had, including the 2004 birth. Fetal deaths are excluded.

Live-birth order indicates what number the present birth represents; for example, a baby born to a mother who has had two previous live births (even if one or both are not now living) has a live-birth order of three. Parity indicates how many live births a mother has had. Before delivery, a mother having her first baby has a parity of zero, and a mother having her third baby has a parity of two. After delivery, the mother of a baby who is a first live birth has a parity of one, and the mother of a baby who is a third live birth has a parity of three.

Live-birth order and parity are determined from two items on the birth certificate, “live births now living” and “live births now dead.” Editing procedures for live birth order are summarized elsewhere (2,14,31).

Not stated birth order—All births tabulated in the “not stated birth order” category are excluded from the computation of percentages. In computing birth rates by live-birth order, births tabulated as birth order not stated are distributed in the same proportion as births of known live-birth order.

Marital status

National estimates of births to unmarried women are based on two methods of determining marital status. For 1994 through 1996, birth certificates in 45 states and the District of Columbia included a question about the mother's marital status. For the other states, marital status is inferred from information on the birth certificate. Beginning in 1997, the marital status of women giving birth in California and Nevada was determined by a direct question in the birth registration process. New York City also changed its procedures for inferring marital status in 1997. Beginning June 15, 1998, Connecticut discontinued inferring the mother’s marital status and added a direct question on mother’s marital status to the state’s birth certificate.

In the two states (Michigan and New York) which used inferential procedures to compile birth statistics by marital status in 2004, a birth is inferred as nonmarital if either of these factors, listed in priority-of-use order, is present: a paternity acknowledgment was received or the father’s name is missing. In recent years, a number of states have extended their efforts to identify the fathers when the parents are not married in order to enforce child support obligations. The presence of a paternity acknowledgment, therefore, is the most reliable indicator that the birth is nonmarital in the states not reporting this information directly; this is now the key indicator in the nonreporting states. Details of the changes in reporting procedures and the impact of the procedures on the data are described in previous reports (32,33).

The mother’s marital status was not reported in 2004 on 0.04 percent of the birth records in the 48 states and the District of Columbia where this information is obtained by a direct question. Marital status was imputed for these records. If status was unknown and the father's age was known, then the mother was considered married. If the status was unknown, and the father's age unknown, then the mother was considered unmarried. This represents a change from the procedures in effect for 2002 and previous years. Prior to 2003, marital status for records with marital status not reported was imputed as "married." Because of the small number of records affected (2,216 births in 2004), the change in imputation procedures had essentially no impact on measures of nonmarital births.

When births to unmarried women are reported as second or higher order births, it is not known whether the mother was married or unmarried when the previous deliveries occurred because her marital status at the time of these earlier births is not available from the birth record.

Educational attainment

Information on educational attainment is reported on both the 2003 Standard Certificate of Live Birth (revised) and 1989 Standard Certificate of Live Birth (unrevised). However, the format of the education item on the revised standard certificate differs substantively from that of the unrevised standard certificate.

The 2003 certificate item asks for the highest degree or level of school completed at the time of the birth (e.g., high school diploma, some college credit but no degree, bachelor degree, etc.), where the 1989 certificate asks for the highest grade of school completed by the mother. Only those years completed in regular schools are counted, that is, a formal educational system of public schools or the equivalent in accredited private or parochial schools. Business or trade schools, such as beauty and barber schools, are not considered regular schools for the purposes of this item. No attempt has been made to convert years of school completed in foreign school systems, ungraded school systems, and so forth, to equivalent grades in the American school system. Such entries are included in the "not stated" category.

Women who have completed only a partial year in high school or college are tabulated as having completed the highest preceding grade or level. For those certificates on which a specific degree is stated, years of school completed is coded to the level at which the degree is most commonly attained; for example, women reporting B.A., A.B., or B.S. degrees are considered to have completed 16 years of school.

In sum, education data for the states that have implemented the revised certificates are not directly comparable with the data for the states that are not yet using the revised certificate. For 2004, unrevised data are available for 41 states, New York City and the District of Columbia and part of the year for Florida and New Hampshire. Revised data are available for all of 2004 for 7 states (Idaho, Kentucky, New York State (excluding New York City), Pennsylvania, South Carolina, Tennessee, and Washington) and part of the year for Florida and New Hampshire.

"Births: Final Data for 2004" provides separate tabulations for the revised and unrevised educational attainment items; see Table D. Table A of this Appendix indicates that education was not stated in 2.0 percent of the unrevised states; among the revised states, levels ranged from 0.8 to 7.5%.

Data on educational attainment are currently available only for the mother (2). Beginning in 1995, NCHS discontinued collecting information on the educational attainment of the father.

Maternal and Infant Health Characteristics

Weight gain during pregnancy

Information on maternal weight gain is available from both the 1989 (unrevised) and the 2003 (revised) Standard Certificate of Live Birth. However, the item was modified. The unrevised question asks for "weight gained during pregnancy ____ lbs." The revised question asks for the pre-pregnancy weight of the mother and her weight at delivery.

In the 2004 file, unrevised data are available through the data year for 40 states, New York City, and the District of Columbia, while revised data are available for 7 states. Two states which had mid-year revisions reported both revised and unrevised data. California did not report weight gain information.

The data from the revised certificate were combined with the data based on the 1989 revision to produce tabulations shown in Tables 22 and 23 of the report Birth: Final Data 2004 (3).

Weight gain in pregnancy is reported in pounds. A reported loss of weight is recorded as zero gain.

Pregnancy risk factors

Both the 2003 and 1989 certificates collect pregnancy risk information in the check box format. Ten medical risks which can affect pregnancy outcome are separately identified on the 2003 Standard Certificate of Live Birth (revised); sixteen on the 1989 Standard Certificate of Live Birth (unrevised). The format allows for the designation of more than one risk factor and includes a choice of "none." Accordingly, if the item is not completed, it is classified as not stated.

Four risk factors are comparable between certificates: diabetes, chronic hypertension, gestational hypertension, and eclampsia. Selected risk factors are shown in Tables 23 to 25 of the report "Births: Final Data for 2004" (3). Supplemental 2004 tables for risk factor data exclusive to the 1989 revision are available on the NCHS website (www.cdc.gov/nchs); a forthcoming report will present risk factor information exclusive to the 2003 revision.

The percent of birth records in which pregnancy risk factor items were not stated was 0.4. Definitions for revised and unrevised items are available elsewhere (3,15).

Tobacco use during pregnancy

Information on smoking during pregnancy was reported on both the 2003 Certificate of Live Birth (revised) and the 1989 Certificate of Live Birth (unrevised). The format of the tobacco use item differs between certificates. Briefly stated, the 1989 revision asks a simple "yes/no" question on tobacco use during pregnancy and the average number of cigarettes per day, with no specificity on timing during the pregnancy. In contrast, the 2003 revision asks for number of cigarettes smoked at different intervals before and during the pregnancy. If the mother reported smoking in any of the three trimesters of pregnancy she was recorded as a smoker.

In the file, for 40 states, New York City, and the District of Columbia, smoking status was based on the 1989 U.S. Standard certificate (unrevised), while data for 6 states are drawn from the 2003 revision of the birth certificate (revised). Florida had a unique smoking use question in its 2003 revision which differed from both the standard revised and unrevised version; resulting data were not comparable to either version. Florida used the standard 1989 revision question during January and February, 2004, and implemented its own revised question starting March 1; New Hampshire used the 1989 revision until July 19 and implemented the standard revised tobacco use question on July 20. California did not report tobacco use in 2004.

The births occurring where the unrevised question was used accounted for 67 percent of U.S. births in 2004. The overall percent of birth records where tobacco use was not stated for the unrevised item was 1.1 percent.

In the report, “Births: Final Data for 2004” (3), data are shown separately in Table E for the areas using the unrevised certificate and for the areas using the revised certificate.

Alcohol use during pregnancy

Data on alcohol use are not collected in the 2003 standard certificate of live birth. Data on alcohol use during pregnancy from the 1989 standard certificate are available for 40 states for the full data year of 2004 and the initial months of 2004 for Florida and New Hampshire. Alcohol use data are not collected on California’s birth certificate. Supplemental 2004 tables for data exclusive to the 1989 revision, including alcohol use during pregnancy, are available on the NCHS website (www.cdc.gov/nchs).

Alcohol use during pregnancy is a major, independent risk factor and it is implicated as well in delayed infant and child development (34,35). Unfortunately, alcohol use is substantially underreported on the birth certificate, compared with data collected in nationally representative surveys of pregnant women. The birth certificate question on alcohol use from the 1989 revision is evidently not sensitive enough to measure this behavior accurately. The question’s wording as well as the lack of specific time reference for the birth certificate questions are probable factors contributing to underreporting. The stigma of maternal alcohol use is also a likely contributor to the underreporting (36,37).

Prenatal care

Information on the timing of prenatal care is available for both the revised and unrevised certificates of live birth. However, the 2003 revision of the birth certificate introduced substantive changes in item wording and also to the sources of prenatal information. The wording of the prenatal care item was modified to “date of first prenatal visit” from “month prenatal care began.” In addition, the 2003 revision process resulted in recommendations that the prenatal care information be gathered from the prenatal care or medical records, whereas the 1989 revision did not recommend a source for these data. Accordingly, prenatal care data for the two revisions are not directly comparable.

For the complete data year 2004, unrevised data on prenatal care are available for 41 states, New York City, and the District of Columbia. Revised data for 7 states (Idaho, Kentucky, New York State (excluding New York City), Pennsylvania, South Carolina, Tennessee, and Washington) are available for all of 2004. Florida and New Hampshire implemented the revised certificate after January 1, 2004.

As noted above, the revised prenatal care item is substantively different from the unrevised question. One result is that levels of utilization of prenatal care based on revised data are substantially lower than those based on unrevised data. For example, unrevised 2003 data for Kentucky indicate that 87.0 of residents began care in the first trimester of pregnancy in 2003. This compares with a level of 74.5 percent based on 2004 revised data. Much, if not all, of the difference between 2003 and 2004 for Kentucky and other revised states, is related to changes in reporting and *not* to changes in prenatal care utilization. Prenatal care utilization results are shown separately according to the two revisions in Tables E, 26(a) and 26(b) of the report Birth: Final Data for 2004 (3).

The 2004 natality data file includes a variable, The Adequacy of Prenatal Care Utilization Index (APNCU). The APNCU is an alternative measure of prenatal care timing which takes into account the number of prenatal care visits and gestational age of the newborn at delivery (38,39). The index in the file is a 4 point scale ranging from “inadequate” to “adequate plus care.” See Table G of the report Birth: Final Data for 2004 (3).

Tabulations of the number of prenatal visits were presented for the first time in 1972. Beginning in 1989, these data were collected from the birth certificates of all states.

Obstetric procedures

The 2003 Standard Certificate of Live Birth (revised) includes three specific check boxes for obstetric procedures; the 1989 certificate includes six procedures. Both certificates have a format which permits the selection of multiple procedures. Birth records with "obstetric procedures" left blank are considered "not stated." Definitions for the unrevised procedures are adapted and abbreviated from a set of definitions compiled by a committee of federal and state health statistics officials for the National Association for Public Health Statistics and Information Systems (NAPHSIS) (3). Definitions for the revised items are included in the detailed facility worksheet guidebook for the 2003 revised certificate only (15). Reporting areas and reporting completeness for obstetric procedures are indicated in Table A of this Appendix.

Tables H and 25 of the report: "Births: Final Data for 2004" (3**)** provide data for the two procedures comparable to both certificates—tocolysis and induction of labor. Supplemental 2004 tables for obstetric procedures exclusive to the 1989 revision are available on the NCHS website (www.cdc.gov/nchs). A forthcoming report will present selected obstetric procedure tables exclusive to the 2003 revision.

Characteristics of labor and of delivery

The 2003 Standard Certificate of Live Birth (revised) includes nine specific check boxes for characteristics of labor and delivery; fifteen characteristics are reported on the 1989 (unrevised) certificate. Both certificates have a format which allows for the reporting of more than one characteristic and includes a choice of "none." Birth records with "characteristics" left blank are considered "not stated." Three characteristics: precipitous labor, breech position, and meconium staining are comparable between the two certificates. The percent of records on which labor and delivery items were not stated and notes on reporting areas are found in Table A.

The complication rates for selected labor/delivery characteristics and their respective reporting areas are given in Table 25 in the report Birth: Final Data for 2004 (3). Supplemental 2004 tables for characteristics of labor and delivery exclusive to the 1989 revision are available on the NCHS website (www.cdc.gov/nchs). A forthcoming report will present selected labor and delivery information exclusive to the 2003 revision.

Definitions for revised and unrevised items are available elsewhere (3,15).

Place of delivery and attendant at birth

Both the 1989 and 2003 revisions of the U.S. Standard Certificate of Live Birth include separate categories for hospitals, freestanding birthing centers, residences, and clinics or doctor's offices as the place of birth. In addition, the 2003 certificate queries whether the home birth was planned to be a home delivery.

For both the revised and unrevised certificates, four professional categories of attendants are medical doctors, doctors of osteopathy, certified nurse midwives, and other midwives. Procedures in some hospitals may require that a physician be listed as the attendant for every birth and that a physician sign each birth certificate, even if the birth is attended by a midwife and no physician is physically present. Therefore, the number of live births attended by midwives may be understated.

Additional information on births occurring outside of hospitals and on birth attendants can be found elsewhere (2).

Tabulations of place of birth and birth attendant are found in Table 27 of the report: Births Final Data for 2004 (3).

Method of delivery

Information on the method of delivery is collected on both the 2003 Standard Certificate of Live Birth (revised) and the 1989 Standard Certificate of Live Birth (unrevised). However, the 2003 revised item is substantially modified from the 1989 item. The 1989 certificate includes, among others, direct questions on vaginal birth after previous cesarean section (VBAC), and primary or repeat cesarean delivery. In contrast, the revised certificate includes a direct question on previous cesarean delivery; whether the delivery was a primary cesarean or was a VBAC must be derived from a question on previous cesarean deliveries under the separate item “risk factors in this pregnancy.”

Despite substantive changes to the method of delivery item, the total numbers and percents of vaginal and cesarean deliveries appear to be very consistent between revisions. (See Tables 28–30 from Birth: Final Data for 2004 (3)). However, information on whether the delivery is a VBAC, primary cesarean, or repeat cesarean appears to be less comparable. In brief, data for the revised states show higher-than-expected VBAC and primary cesarean rates, and lower-than-expected repeat cesarean rates. These discontinuities are likely due to wording and formatting changes to the method of delivery item on the 2003 Revision of the U.S. Standard Certificate of Live Birth. The changes to the method of delivery item appear to have a small impact (2–3 percent) on the national primary and VBAC rates shown in the 2004 natality report (3). Measures which incorporate these data to compare changes across revisions for individual states should be interpreted with caution.

Information on forceps and vacuum delivery are also available from both revisions of the birth certificate; these data appear to be comparable between revisions. The 2003 revision item was also expanded to include questions on whether attempted forceps or vacuum deliveries were successful, and whether a trial of labor was attempted prior to cesarean delivery. These and other new data on method of delivery are available on the 2004 file and will be presented in a forthcoming report.

Several rates are computed for method of delivery. The overall cesarean section rate or total cesarean rate is computed as the proportion of all births that were delivered by cesarean section. The primary cesarean rate is a measure that relates the number of women having a primary cesarean birth to all women giving birth who have never had a cesarean delivery. The denominator for this rate is the sum of women with a vaginal birth excluding VBACs and women with a primary cesarean birth. The VBAC delivery rate is computed by relating all VBAC deliveries to the sum of VBAC and repeat cesarean deliveries, that is, to women with a previous cesarean section.

Period of gestation

The period of gestation is defined as beginning with the first day of the last normal menstrual period (LMP) and ending with the day of the birth. The LMP is used as the initial date because it can be more accurately determined than the date of conception, which usually occurs 2 weeks after the LMP. LMP measurement is subject to error for several reasons, including imperfect maternal recall or misidentification of the LMP because of post-conception bleeding, delayed ovulation, or intervening early miscarriage.

Births occurring before 37 completed weeks of gestation are considered to be preterm for purposes of classification. At 37–41 weeks gestation, births are considered to be term, and at 42 completed weeks and over, post-term. These distinctions are according to the ICD–9 and ICD–10 (8) definitions. See Tables 31 and 32 in the 2004 natality report.

Before 1981, the period of gestation was computed only when there was a valid month, day, and year of LMP. However, length of gestation could not be determined from a substantial number of live-birth certificates each year because the day of LMP was missing. Beginning in 1981, weeks of gestation have been imputed for records with missing day of LMP when there is a valid month and year. The imputation procedure and its effect on the data are described elsewhere (2,40), but reporting problems for this item persist and may occur more frequently among some subpopulations and among births with shorter gestations. Changes in reporting of this measure over time have affected trends in preterm birth rates, particularly by race (41).

The 1989 revision of the U.S. Standard Certificate of Live Birth includes an item, “clinical estimate of gestation” (CE); in the 2003 revision of the certificate, the item is “obstetric estimate of gestation” (OE)—see definitions (15). Both measures are in completed weeks. The OE and the CE are compared with length of gestation computed from the LMP date when the latter appears to be inconsistent with birthweight. This is done for normal weight births of apparently short gestations and very low birthweight births reported to be full term. The procedures are described in the NCHS instruction manuals, Part 12, (see NCHS (31) for the 1989 revision; NCHS (42) for the 2003 revision). The clinical or obstetric estimate is reported by all areas except California for 2004.

The period of gestation for 5.9 percent of the births in 2004 was based on the clinical estimate of gestation. For 97 percent of these records, the clinical or obstetric estimate was used because the LMP date was not reported. For the remaining 3 percent, the clinical or obstetric estimate was used because it was compatible with the reported birthweight, whereas the LMP-based gestation was not. In cases where the reported birthweight was inconsistent with both the LMP-computed gestation and the clinical estimate of gestation, the LMP-computed gestation was used and birthweight was reclassified as "not stated." This was necessary for 1,302 births or 0.04 percent of all birth records in 2004, significantly higher than for 2003**.** Despite these edits, substantial incongruities in these data persist; research is ongoing to address these data deficiencies.

Gestational age data are shown in Tables 31 and 32 of the report: "Births: Final Data for 2004."

Birthweight

In some areas, birthweight is reported in pounds and ounces rather than in grams. However, the metric system has been used in tabulating and presenting the statistics to facilitate comparison with data published by other groups. The categories for birthweight are consistent with the recommendations in the *International Classification of Diseases, Ninth Revision* (ICD–9) and the *International Classification of Diseases, Tenth Revision* (ICD–10) (8). The categories in gram intervals and their equivalents in pounds and ounces are as follows:

Less than 500 grams = 1 lb 1 oz or less
500–999 grams = 1 lb 2 oz–2 lb 3 oz
1,000–1,499 grams = 2 lb 4 oz–3 lb 4 oz
1,500–1,999 grams = 3 lb 5 oz–4 lb 6 oz
2,000–2,499 grams = 4 lb 7 oz–5 lb 8 oz
2,500–2,999 grams = 5 lb 9 oz–6 lb 9 oz
3,000–3,499 grams = 6 lb 10 oz–7 lb 11 oz
3,500–3,999 grams = 7 lb 12 oz–8 lb 13 oz
4,000–4,499 grams = 8 lb l4 oz–9 lb l4 oz
4,500–4,999 grams = 9 lb 15 oz–11 lb 0 oz
5,000 grams or more = 11 lb l oz or more

ICD–9 and ICD–10 define low birthweight as less than 2,500 grams. This is a shift of 1 gram from the previous criterion of 2,500 grams or less, which was recommended by the American Academy of Pediatrics in 1935 and adopted in 1948 by the World Health Organization in the *International Lists of Diseases and Causes of Death, Sixth Revision* (43). Very low birthweight is defined as less than 1,500 grams.

To establish the continuity of class intervals needed to convert pounds and ounces to grams, the end points of these intervals are assumed to be half an ounce less at the lower end and half an ounce more at the upper end. For example, 2 lb 4 oz–3 lb 4 oz is interpreted as 2 lb 3 ½ oz–3 lb 4 ½ oz. Births for which birthweights are not reported are excluded from the computation of percentages. The panel that proposed the 2003 revised certificate recommended that birthweight be reported in grams rather than pounds for data entry (12).

Birthweight data are shown in Tables 31, 32, 34–36 of the 2004 natality report (3).

Apgar score

The 1– and 5–minute Apgar scores were added to the U.S. Standard Certificate of Live Birth in 1978 to evaluate the condition of the newborn infant at 1 and 5 minutes after birth. The 2003 revised certificate asks for a 10 minute score if the 5 minute score was less than 6. The Apgar score is a measure of the need for resuscitation and a predictor of the infant's chances of surviving the first year of life. It is a summary measure of the infant's condition based on heart rate, respiratory effort, muscle tone, reflex irritability, and color. Each of these factors is given a score of 0, 1, or 2; the sum of these 5 values is the Apgar score, which ranges from 0 to 10. A score of 0 to 3 indicates an infant in need of resuscitation; a score of 4 to 6 is considered intermediate; a score of 7 or greater indicates that the neonate is in good to excellent physical condition.

Beginning in 1995, NCHS collected information only on the 5–minute Apgar score. Since 1991, the reporting area for the 5–minute Apgar score has been comprised of 48 states and the District of Columbia. California and Texas did not collect information on Apgar scores on their birth certificates. For 0.5 percent of the births in the reporting area, there were no Apgar scores reported. Five minute Apgar sores are given in Table L of the report: “Birth: Final Data for 2004” (3). Revised data for the 10 minute score are not available in the 2004 file.

Plurality

Comparable plurality data are reported in the 2003 and 1989 Standard Certificates of Live Birth. In this file, plurality is classified as single, twin, triplet, quadruplet, and quintuplet and higher order births. Each record in the natality file represents an individual birth. For example, a record coded as a twin represents one birth in a twin delivery. Pairs or sets of twins or higher order multiple births are not identified in this file. The Matched Multiple Birth File 1995–2000 (44) includes information on sets of twin, triplet and quadruplets, thus allowing for the analysis of characteristics of sets of births and fetal deaths in multiple deliveries.

Numbers and rates of births by plurality are given in Tables 37–39 of the report: Birth: Final Data for 2004 (3). Records for which plurality is unknown are imputed as singletons. This occurred for 0.003 percent of all records for 2004.

Abnormal conditions of the newborn

Information on abnormal conditions of the newborn is obtained from the check boxes on the 1989 and 2003 certificate revisions. There are seven specific abnormal conditions included on the 2003 revised birth certificate; eight are included on the 1989 certificate. More than one abnormal condition may be reported for a given birth or “none” may be selected. If the item is not completed it is tabulated as not stated.

There are no comparable abnormal conditions between the 1989 and 2003 certificate. However, both unrevised and revised items are included in the 2004 Natality Public Use File. Supplemental 2004 tables for abnormal conditions of the newborn exclusive to the 1989 revision are available on the NCHS website (www.cdc.gov/nchs). A forthcoming report will present selected abnormal conditions information exclusive to the 2003 revision. Definitions are available elsewhere (3,15). For information on reporting areas and for percent of birth records with conditions not stated, see Table A.

Congenital anomalies of the newborn

Twelve specific anomalies or anomaly groups are collected on the 2003 Standard Certificate of Live Birth, and 21 anomalies are collected on the 1989 standard certificate of live birth. The check box format allows for the identification of more than one anomaly including a choice of “none” should no anomalies be evident. The “not stated” category includes birth records for which the item is not completed.

There are five congenital anomalies in common to the two revisions of the birth certificate: anencephalus, spina bifida/meningocele, omphalocele/gastroschisis, cleft lip/palate and Downs syndrome; see Table 25 of the report “Births: Final Data for 2004” (3).

It is well documented that congenital anomalies, except for the most visible and most severe, are incompletely reported on birth certificates (45). The completeness of reporting specific anomalies depends on how easily they are recognized in the short time between birth and birth-registration. For 1.2 percent of the birth records, there were incomplete check boxes for congenital anomalies.

Definitions for the revised and unrevised congenital anomalies are available elsewhere (3,15). See Table A for reporting areas and for percent of records for which data on congenital anomalies is not stated.

Quality of Data

Although vital statistics data are useful for a variety of administrative and scientific purposes, they cannot be correctly interpreted unless various qualifying factors and methods of classification are taken into account. The factors to be considered depend on the specific purposes for which the data are to be used. It is not feasible to discuss all the pertinent factors in the use of vital statistics tabulations, but some of the more important ones should be mentioned.

Most of the factors limiting the use of data arise from imperfections in the original records or from the impracticability of tabulating these data in very detailed categories. These limitations should not be ignored, but their existence does not lessen the value of the data for most general purposes.

Completeness of registration

It is estimated that more than 99 percent of all births occurring in the United States in 2004 were registered. These estimates are based on the results of a national 1964–68 test of birth-registration completeness according to place of delivery (in or out of hospital) and race (white and non-white). This test has not been conducted more recently. A detailed discussion of the method and results of the 1964–68 birth-registration test is available (46). Information on procedures for adjusting births for under registration (for cohort fertility tables) is presented elsewhere (2).

Completeness of reporting

Interpretation of these data must include evaluation of item completeness. The “not stated” percentage is one measure of the quality of the data. Completeness of reporting varies among items and states. See Table A for the percentage of birth records on which specified items were not stated. Data users should note that levels of incomplete or inaccurate reporting for some of the items are quite high in some states. The 2004 data for Alaska and the District of Columbia are of particular concern.

Quality control procedures

As electronic files are received at NCHS, they are automatically checked for completeness, individual item code validity, and unacceptable inconsistencies between data items. The registration area is notified of any problems. In addition, NCHS staff reviews the files on an ongoing basis to detect problems in overall quality such as inadequate reporting for certain items, failure to follow NCHS coding rules, and systems and software errors. Traditionally, quality assurance procedures were limited to the review and analysis of differences between NCHS and registration area code assignments for a small sample of records. In recent years, as electronic birth registration became prevalent, this procedure was augmented by analyses of year-to-year and area-to-area variations in the data. These analyses are based on preliminary tabulations of the data that are cumulated by state on a year-to-date basis each month. NCHS investigates all differences that are judged to have consequences for quality and completeness. In the review process, statistical tests are used to call initial attention to differences for possible follow-up. As necessary, registration areas are informed of differences encountered in the tables and asked to verify the counts or to determine the nature of the differences. Missing records (except those permanently voided) and other problems detected by NCHS are resolved, and corrections are transmitted to NCHS in the same manner as for those corrections identified by the registration area.

Computation of Rates and Other Measures

Population bases

Estimation by age, sex, race and Hispanic origin—Birth and fertility rates for 2004 shown in Tables 1, 3–5, 7–9, 11, 14–15, 21, A, and B in the report: “Births: Final Data for 2004” (3) are computed using 2000 census-based post-censal (population) estimates as of July 1, 2004. These populations are shown in Tables 4–2 and 4–3. The population estimates have been provided by the U.S. Census Bureau (47) and are based on the 2000 census counts by age, sex, race, and Hispanic origin, which have been modified to be consistent with Office of Management and Budget racial categories as of 1977 and historical categories for birth data. The modification procedures are described in detail elsewhere (48).

Birth and fertility rates by state shown in Table 10 of the report: “Births: Final Data for 2004” (3) use 2000 census-based state-level post-censal population estimates provided by the U.S. Census Bureau (47**).** Rates by state shown in this report may differ from rates computed on the basis of other population estimates. Birth and fertility rates by month shown in Table 16 of the 2004 natality final report (3) are based on monthly population estimates. Rates for unmarried women shown in Tables 18 and 19 of the 2004 natality final report (3) are based on distributions of the population by marital status as of March 2004 as reported by the U.S. Census Bureau in the March Current Population Survey (CPS) (49), which have been adjusted to July 2004 population levels (47) by the Division of Vital Statistics, NCHS (3)**.** Birth and fertility rates for the Hispanic population, shown in Tables 5, 7, 8, 9, and 15 of the 2004 natality final report (3)**,** are based on estimates of the total Hispanic population as of July 1, 2004 (47). Rates for Hispanic subgroups are based on special population estimates that are presented in Table 4–3. Information about allocation to Hispanic subgroups is presented elsewhere (50).

The populations by race used in this report were produced under a collaborative arrangement with the U.S. Census Bureau and are 2000 census-based post-censual estimates. Reflecting the new guidelines issued in 1997 by the Office of Management and Budget (OMB), the 2000 census included an option for individuals to report more than one race as appropriate for themselves and household members (22). In addition, the 1997 OMB guidelines called for reporting of Asian persons separately from Native Hawaiians or other Pacific Islanders. In the 1977 OMB guidelines, data for Asian or Pacific Islander persons were collected as a single group (21). Except for fifteen states, birth certificates currently report only one race for each parent in the categories specified in the 1977 OMB guidelines (see "Hispanic origin, race and national origin"). In addition, unrevised birth certificate data do not report Asians separately from Native Hawaiians or other Pacific Islanders. Thus, birth certificate data by race (the numerators for birth and fertility rates) currently are incompatible with the population data collected in the 2000 census (the denominators for the rates).

To produce birth and fertility rates for 2000 through 2004, it was necessary to bridge the population data for multiple race persons back to single race categories. In addition, the postcensal estimates were modified to be consistent with the 1977 OMB racial categories, that is, to report the data for Asian persons and Native Hawaiians or other Pacific Islanders as a combined category Asian or Pacific Islanders (51). The procedures used to produce the bridged populations are described in separate publications

(23,24). In 2003, six states began reporting multiple race data; and in 2004, 15 states. Once all states revise their birth certificates to be compliant with the 1997 OMB standards, the use of bridged populations can be discontinued.

Populations used to calculate the rates for 1991–99 are based on population estimates as of July 1 of each year and were produced by the U.S. Census Bureau, with support from the National Cancer Institute (23, 47, 52, 53). These intercensal population estimates for 1991–99 are based on the April 1, 2000 census. The bridged rates for 1990 and 2000 are based on populations from the censuses in those years as of April 1.

Readers should keep in mind that the population data used to compile birth and fertility rates by race and ethnicity shown in this report are based on special estimation procedures, and are not actual counts. This is the case even for the 2000 populations that are based on the 2000 census. As a result, the estimation procedures used to develop these populations may contain some errors. Smaller populations, American Indians, for example, are likely to be affected much more than larger populations by potential measurement error (23). While the nature and magnitude of error is unknown, the potential for error should be kept in mind when evaluating trends and differentials.

As more accurate information becomes available, further revisions of the estimates may be necessary. Additional information on the revised populations is available at: http://www.cdc.gov/nchs/about/major/dvs/popbridge/popbridge.htm.

Residential population base—Birth rates for the United States, individual states, and metropolitan areas are based on the total resident populations of the respective areas (Table 4–4). Except as noted, these populations exclude the Armed Forces abroad but include the Armed Forces stationed in each area. The residential population of the birth- and death-registration states for 1900–1932 and for the United States for 1900–2004 is shown in Table 4–1. In addition, the population including Armed Forces abroad is shown for the United States. Table D shows the sources for these populations. A detailed discussion of historical population bases is presented elsewhere (2).

Small populations as denominators—An asterisk (*) is shown in place of any derived rate based on fewer than 20 births in the numerator, or a population denominator of less than 50 (unweighted) for decennial years and 75,000 (weighted) for all other years for the Hispanic subgroups. Rates based on populations below these minimum levels lack sufficient reliability for analytic purposes.

Net census undercounts and overcounts—Studies conducted by the U.S. Census Bureau indicate that some age, race, and sex groups are more completely enumerated than others. Census miscounts can have consequences for vital statistics measures. For example, an adjustment to increase the population denominator would result in a smaller rate compared to the unadjusted rate. A more detailed discussion of census undercounts and overcounts can be found in the 1999 Technical Appendix (2). Adjusted rates for 2000 can be computed by multiplying the reported rates by ratios from the 2000 census-level population adjusted for the estimated age-specific census over- and undercounts, which are shown in Table E.

Cohort fertility tables

Various fertility measures for cohorts of women are computed from births adjusted for under-registration and population estimates corrected for under enumeration and misstatement of age. Data published after 1974 use revised population estimates prepared by the U.S. Census Bureau and have been expanded to include data for the two major racial groups. Heuser (54) has prepared a detailed description of the methods used in deriving these measures as well as more detailed data for earlier years. The series of cohort fertility tables are being revised to incorporate rates for black women and the revised intercensal population estimates of the 1990s. A publication is forthcoming.

Parity distribution—The percentage distribution of women by parity (number of children ever born alive to mother) is derived from cumulative birth rates by order of birth. The percentage of zero-parity women is found by subtracting the cumulative first birth rate from 1,000 and dividing by 10. The proportions of women at parities one through six are found from the following formula:

Percent at N parity = ((cum. rate, order N)-(cum. rate, order N + 1))/10

The percentage of women at seventh and higher parities is found by dividing the cumulative rate for seventh-order births by 10.

Birth probabilities—Birth probabilities indicate the likelihood that a woman of a certain parity and age at the beginning of the year will have a child during the year. Birth probabilities differ from central birth rates in that the denominator for birth probabilities is specific for parity as well as for age.

Total fertility rate

The total fertility rate is the sum of the birth rates by age of mother (in 5-year age groups) multiplied by 5. It is an age-adjusted rate because it is based on the assumption that there is the same number of women in each age group. The rate of 2,045.5 in 2004, for example, means that if a hypothetical group of 1,000 women were to have the same birth rates in each age group that were observed in the actual childbearing population in 2004, they would have a total of 2,046 children by the time they reached the end of the reproductive period (taken here to be age 50 years), assuming that all of the women survived to that age.

Seasonal adjustment of rates

The seasonally adjusted birth and fertility rates are computed from the X–11 variant of Census Method II (55). This method, used since 1964, differs slightly from the U.S. Bureau of Labor Statistics (BLS) Seasonal Factor Method, which was used for *Vital Statistics of the United States*, 1964. The fundamental technique is the same in that it is an adaptation of the ratio-to-moving-average method. Before 1964, the method of seasonal adjustment was based on the X–9 variant and other variants of Census Method II. A comparison of the Census Method II with the BLS Seasonal Factor Method shows the differences in the seasonal patterns of births to be negligible.

Computations of percentages, percentage distributions, and means

Births for which a particular characteristic is unknown were subtracted from the figures for total births that were used as denominators before percentages, percentage distributions, and means were computed. The percentage of records with missing information for each item is shown by state in Table A. The mean age of mother is the arithmetic average of the age of mothers at the time of birth, computed directly from the frequency of births by age of mother. An asterisk is shown in place of any derived statistic based on fewer than 20 births in the numerator or denominator.

Computation of Measures of Variability

Random variation and significance testing for natality data

This detailed discussion of random variation and significance testing for natality data is similar to that in the Technical Notes of "Births: Final data for 2004" (3). The number of births reported for an area is essentially a complete count, because more than 99 percent of all births are registered. Although this number is not subject to sampling error, it may be affected by nonsampling errors such as mistakes in recording the mother's residence or age during the registration process.

When the number of births is used for analytical purposes (that is, for the comparison of numbers, rates, and percents over time, for different areas, or between different groups), the number of events that *actually* occurred can be thought of as one outcome in a large series of possible results that *could have* occurred under the same (or similar) circumstances. When considered in this way, the number of births is subject to random variation and a probable range of values estimated from the actual figures, according to certain statistical assumptions.

The confidence interval is the range of values for the number of births, birth rates, or percent of births that you could expect in 95 out of 100 cases. The confidence limits are the end points of this range of values (the highest and lowest values). Confidence limits tell you how much the number of events or rates could vary under the same (or similar) circumstances.

Confidence limits for numbers, rates, and percents can be estimated from the actual number of vital events. Procedures differ for rates and percents and also differ depending on the number of births on which these statistics are based. Below are detailed procedures and examples for each type of case.

When the number of vital events is large, the distribution is assumed to follow a normal distribution (where the relative standard error is small). When the number of events is small and the probability of the event is small, the distribution is assumed to follow a Poisson probability distribution. Considerable caution should be observed in interpreting the occurrence of infrequent events.

95-percent confidence limits for numbers less than 100—When the number of births is less than 100 and the rate is small, the data are assumed to follow a Poisson probability distribution (56). Confidence limits are estimated using the following formulas:

$$\text{Lower limit} = B \times L$$
$$\text{Upper limit} = B \times U$$

where:

B = number of births

L = the value in Table C that corresponds to the number B

U = the value in Table C that corresponds to the number B

<u>Example</u>

Suppose that the number of first births to American Indian women 40–44 years of age was 47. The confidence limits for this number would be:

$$\begin{aligned}\text{Lower limit} &= 47 \times 0.73476 \\ &= 35\end{aligned}$$

$$\begin{aligned}\text{Upper limit} &= 47 \times 1.32979 \\ &= 63\end{aligned}$$

This means that the chances are 95 out of 100 that the actual number of first births to American Indian women 40–44 years of age would lie between 35 and 63.

95-percent confidence limits for numbers of 100 or more—When the number of events is greater than 100, the data are assumed to approximate a normal distribution. Formulas for 95-percent confidence limits are:

$$\text{Lower limit} = B - \left(1.96 \times \sqrt{B}\right)$$

$$\text{Upper limit} = B + \left(1.96 \times \sqrt{B}\right)$$

where:

B = number of births

Example

Suppose that the number of first births to white women 40–44 years of age was 14,108. The 95-percent confidence limits for this number would be:

$$\begin{aligned}\text{Lower limit} &= 14{,}108 - \left(1.96 \times \sqrt{14{,}108}\right)\\ &= 14{,}108 - 233\\ &= 13{,}875\end{aligned}$$

$$\begin{aligned}\text{Lower limit} &= 14{,}108 + \left(1.96 \times \sqrt{14{,}108}\right)\\ &= 14{,}108 + 233\\ &= 14{,}341\end{aligned}$$

This means that the chances are 95 out of 100 that the actual number of first births to white women 40–44 years of age would fall between 13,875 and 14,341.

Computing confidence intervals for rates—The same statistical assumptions can be used to estimate the variability in birth rates. Again, one formula is used for rates based on numbers of events less than 100, and another formula for rates based on numbers of 100 or greater. For our purposes, assume that the denominators of these rates (the population estimates) have no error. While this assumption is technically correct *only* for denominators based on the census that occurs every 10 years, the error in intercensal population estimates is usually small, difficult to measure, and therefore not considered. (See, however, earlier discussion of population denominators in the section on “population bases”).

95-percent confidence limits for rates based on fewer than 100 events —As stated earlier, when the number of events in the numerator is less than 20 (or the population denominator is less than 50 for decennial years and 75,000 for all other years for an estimated subgroups), an asterisk (*) is shown in place of the rate because there were too few births or the population is too small to compute a statistically reliable rate. When the number of events in the numerator is greater than 20 but less than 100 (and the population denominator for the subgroups is above the minimum), the confidence interval for a rate can be estimated using the two formulas which follow and the values in Table C.

$$\text{Lower limit} = R \times L$$

$$\text{Upper limit} = R \times U$$

where:

R	=	birth rate
L	=	the value in Table C that corresponds to the number of events B
U	=	the value in Table C that corresponds to the number of events B

Example

Suppose that the first birth rate for American Indian women 40–44 years of age was 0.50 per thousand, based on 47 births in the numerator. Using Table C:

$$\begin{aligned}\text{Lower limit} &= 0.50 \times 0.73476 \\ &= 0.37\end{aligned}$$

$$\begin{aligned}\text{Upper limit} &= 0.50 \times 1.32979 \\ &= 0.66\end{aligned}$$

This means that the chances are 95 out of 100 that the actual first birth rate for American Indian women 40–44 years of age would be between 0.37 and 0.66.

95-percent confidence limits for rates when the numerator is 100 or more—In this case, use the following formula for the birth rate R based on the number of births B:

$$\text{Lower limit} = R - \left(1.96 \times \left(R / \sqrt{B}\right)\right)$$

$$\text{Upper limit} = R + \left(1.96 \times \left(R / \sqrt{B}\right)\right)$$

where:

R	=	birth rate

B = number of births

Example

Suppose that the first birth rate for white women 40–44 years of age was 1.55 per thousand, based on 14,108 births in the numerator. Therefore, the 95-percent confidence interval would be:

$$\begin{aligned}\text{Lower limit} &= 1.55 - \left(1.96 \times \left(1.55 / \sqrt{14{,}108}\right)\right) \\ &= 1.55 - 0.026 \\ &= 1.52\end{aligned}$$

$$\begin{aligned}\text{Upper limit} &= 1.55 + \left(1.96 \times \left(1.55 / \sqrt{14{,}108}\right)\right) \\ &= 1.55 + 0.026 \\ &= 1.58\end{aligned}$$

This means that the chances are 95 out of 100 that the actual first birth rate for white women 40–44 years of age lies between 1.52 and 1.58.

Computing 95-percent confidence intervals for percents—In many instances we need to compute the confidence intervals for percents. Percents derive from a binomial distribution. As with birth rates, an asterisk (*) will be shown for any percent which is based on fewer than 20 births in the numerator. We easily compute a 95-percent confidence interval for a percent when the following conditions are met:

$$B \times p \geq 5 \text{ and } B \times q \geq 5$$

where:

B = number of births in the denominator

p = percent divided by 100

q = 1 - p

For natality data, these conditions will be met except for very rare events in small subgroups. If the conditions are not met, the variation in the percent will be so large as to render the confidence intervals meaningless. When these conditions are met the 95-percent confidence interval can be computed using the normal approximation of the binomial. The 95-percent confidence intervals are computed by the following formulas:

$$\text{Lower limit} = p - \left(1.96 \bullet \left(\sqrt{p \bullet q / B}\right)\right)$$

$$\text{Upper limit} = p + \left(1.96 \bullet \left(\sqrt{p \bullet q / B}\right)\right)$$

where:

p	=	percent divided by 100
q	=	1- *p*
B	=	number of births in the denominator

Example

Suppose that the percent of births to Hispanic women in Arizona that were to unmarried women was 49.7 percent. This was based on 14,751 births in the numerator and 29,682 births in the denominator. First we test to make sure we can use the normal approximation of the binomial:

$$29{,}682 \times 0.497 = 14{,}752$$

$$29{,}682 \times (1 - 0.497) = 29{,}682 \times 0.503 = 14{,}930$$

Both 14,752 and 14,930 are greater than 5, so we can proceed. The 95-percent confidence interval would be:

$$\begin{aligned}\text{Lower limit} &= 0.497 - \left(1.96 \bullet \left(\sqrt{0.497 \bullet 0.503 / 29{,}682}\right)\right)\\ &= 0.497 - 0.006\\ &= 0.491 \text{ or } 49.1 \text{ percent}\end{aligned}$$

$$
\begin{aligned}
\text{Upper limit} &= 0.497 + \left(1.96 \bullet \left(\sqrt{0.497 \bullet 0.503 / 29{,}682}\right)\right) \\
&= 0.497 + 0.006 \\
&= 0.503 \text{ or } 50.3 \text{ percent}
\end{aligned}
$$

This means that the chances are 95 out of 100 that the actual percent of births to unmarried Hispanic women in Arizona is between 49.1 and 50.3 percent.

Significance testing when one or both of the rates is based on fewer than 100 cases—To compare two rates, when one or both of those rates are based on less than 100 cases, you first compute the confidence intervals for both rates. Then you check to see if those intervals overlap. If they **do** overlap, the difference is not statistically significant at the 95-percent level. If they **do not** overlap, the difference is indeed statistically significant.

Example

Suppose that the first birth rate for American Indian women 40–44 years of age was 0.70 per 1,000 in Year X and 0.57 in Year Y. Is the rate for Year X significantly higher than the rate for Year Y? The two rates are based on 63 events in Year X and 54 events in Year Y. Both rates are based on fewer than 100 events; therefore, the first step is to compute the confidence intervals for both rates.

	Lower Limit	Upper Limit
Year X	0.54	0.90
Year Y	0.43	0.74

These two confidence intervals overlap. Therefore, the first birth rate for American women 40–44 in Year X is not significantly higher (at the 95-percent confidence level) than the rate in Year Y.

This method of comparing confidence intervals is a conservative test for statistical significance. That is, the difference between two rates may, in fact, be statistically significant even though confidence intervals for the two rates overlap (57). Thus, caution should be observed when interpreting a non-significant difference between two rates, especially when the lower and upper limits being compared overlap only slightly.

Significance testing when both rates are based on 100 or more events—When both rates are based on 100 or more events, the difference between the two rates, irrespective of sign (+/-), is considered statistically significant if it exceeds the statistic in the formula below. This statistic equals 1.96 times the standard error for the difference between two rates.

$$1.96 \times \sqrt{\frac{R_1^2}{N_1} + \frac{R_2^2}{N_2}}$$

where:

R_1 = first rate

R_2 = second rate

N_1 = first number of births

N_2 = second number of births

If the difference is **greater** than this statistic, then the difference would occur by chance less than 5 times out of 100. If the difference is **less than or equal** to this statistic, the difference might occur by chance more than 5 times out of 100. We say that the difference is not statistically significant at the 95-percent confidence level.

Example

Is the first birth rate for black women 40–44 years of age (1.08 per 1,000) significantly lower than the comparable rate for white women (1.55)? Both rates are based on more than 100 births (1,535 for black women and 14,108 for white women). The difference between the rates is 1.55 - 1.08 = 0.47. The statistic is then calculated as follows:

$$\begin{aligned}
&= 1.96 \times \sqrt{\frac{1.08^2}{1{,}535} + \frac{1.55^2}{14{,}108}} \\
&= 1.96 \times \sqrt{((1.166/1{,}535) + (2.403/14{,}108))} \\
&= 1.96 \times \sqrt{0.00076 + 0.00017} \\
&= 1.96 \times \sqrt{0.00093} \\
&= 1.96 \times 0.03 \\
&= 0.06
\end{aligned}$$

The difference between the rates (0.47) is greater than this statistic (0.06). Therefore, the difference is statistically significant at the 95-percent confidence level.

Significance testing differences between two percents—When testing the difference between two percents, both percents must meet the following conditions:

$$B \times p \geq 5 \text{ and } B \times q \geq 5$$

where:

B = number of births in the denominator

p = percent divided by 100

q = 1 - p

When both percents meet these conditions then the difference between the two percents is considered statistically significant if it is greater than the statistic in the formula below. This statistic equals 1.96 times the standard error for the difference between two percents.

$$1.96 \times \sqrt{p \times (1 - p) \times \left(\frac{1}{B_1} + \frac{1}{B_2}\right)}$$

where:

B_1 = number of births in the denominator of the first percent

B_2 = number of births in the denominator of the second percent

p = $\dfrac{B_1 \times p_1 + B_2 \times p_2}{B_1 + B_2}$

p_1 = the first percent divided by 100

p_2 = the second percent divided by 100

Example

Is the percent of births to Hispanic women that were to unmarried women higher in New Mexico (50.2) than in Arizona (49.7)? Suppose that the number in the denominator was 13,714 in New Mexico and 29,682 in Arizona. The necessary conditions are met for both percents (calculations not shown). The difference between the two percents is 0.502 - 0.497 = 0.005. The statistic is then calculated as follows:

$$
\begin{aligned}
&1.96 \times \sqrt{0.499 \times (0.501) \times (0.000106609)} \\
&= 1.96 \times \sqrt{0.000026652} \\
&= 1.96 \times 0.005162563 \\
&= 0.010
\end{aligned}
$$

The difference between the percents (0.005) is less than this statistic (0.010). Therefore, the difference is not statistically significant at the 95-percent confidence level.

Random variation and significance testing for population subgroups

This section presents information relevant to Hispanic subgroups (or generally speaking, <u>any</u> subgroup of the population for which <u>survey</u> data has been used for estimation of the denominator.) Birth and fertility rates for Mexicans, Puerto Ricans, Cubans, and “other” Hispanic subgroups for 2004 are shown in Tables 5,6, 8, and 15 of 2004 natality final report (3) and in Tables 1–4 and 1–12 of Vital Statistics of the United States, 2004, Part 1, Natality (forthcoming). <u>Population estimates</u> for Hispanic subgroups are derived from the U.S. Census Bureau’s *Current Population Survey* (CPS) and adjusted to resident population control totals as shown in Table 4–3 (47,50). As a result, the rates are subject to the variability of the denominator as well as the numerator. For these Hispanic subgroups (but not for all origin, total Hispanic, total non-Hispanic, non-Hispanic white, or non-Hispanic black populations), the following formulas are used for testing statistical significance in trends and differences:

Approximate 95-percent confidence interval: 100 or more births—When the number of events in the numerator is greater than 100, the confidence interval for the birth rate can be estimated from the following formulas: For crude and age–specific birth rates,

$$\text{Lower limit} = R - 1.96 * R * \sqrt{\left(\frac{1}{B}\right) + f\left(a + \frac{b}{P}\right)}$$

$$\text{Upper limit} = R + 1.96 * R * \sqrt{\left(\frac{1}{B}\right) + f\left(a + \frac{b}{P}\right)}$$

where:

R = rate (births per 1,000 population)
B = total number of births upon which rate is based
f = the factor which depends on whether an entire or a sampled population (like one from a Current Population Survey – CPS) is used, and the span of years represented. *f* equals 0.670 for a single year
a and *b* of the example are single year averages of the 2002 and 2003 CPS standard error parameters (58,59)
a = -0.000096
b = 3,809
P = total estimated population upon which rate is based

<u>Example</u>

Suppose that the fertility rate of Cuban women 15–44 years of age was 51.2 per 1,000 based on 13,088 births in the numerator and an estimated resident population of 255,399 in the denominator. The 95-percent confidence interval would be:

$$\begin{aligned}\text{Lower limit} &= 51.2 - 1.96 * 51.2 * \sqrt{\left(\frac{1}{13{,}088}\right) + 0.670 * \left[-0.000096 + \left(\frac{3{,}809}{255{,}399}\right)\right]} \\ &= 51.2 - 1.96 * 51.2 * \sqrt{0.000076406 + (0.670 * 0.014914)} \\ &= 51.2 - 1.96 * 51.2 * \sqrt{0.01000475} \\ &= 51.2 - 1.96 * 51.2 * 0.100024 \\ &= 41.16\end{aligned}$$

$$\begin{aligned}\text{Upper limit} &= 51.2 + 1.96 * 51.2 * \sqrt{\left(\frac{1}{13{,}088}\right) + 0.670 * \left[-0.000096 + \left(\frac{3{,}809}{255{,}399}\right)\right]} \\ &= 51.2 + 1.96 * 51.2 * \sqrt{0.000076406 + (0.670 * 0.014914)} \\ &= 51.2 + 1.96 * 51.2 * \sqrt{0.01000475} \\ &= 51.2 + 1.96 * 51.2 * 0.100024 \\ &= 61.24\end{aligned}$$

This means that the chances are 95 out of 100 that the actual fertility rate of Cuban women 15–44 years of age is between 41.16 and 61.24.

Approximate 95-percent confidence interval: less than 100 births—When the number of events in the numerator is less than 20, an asterisk is shown in place of the rate. When the number of events in the numerator is greater than 20 but less than 100, the confidence interval for the birth rate can be estimated using the formulas that follow and the values in Table C.

For crude and age-specific birth rates,

$$\text{Lower limit} = R * L(1-\alpha = .96, B) * \left(1 - 2.576\sqrt{f\left(a + \frac{b}{P}\right)}\right)$$

$$\text{Upper limit} = R * U(1-\alpha = .96, B) * \left(1 + 2.576\sqrt{f\left(a + \frac{b}{P}\right)}\right)$$

where:

R = rate (births per 1,000 population)
B = total number of births upon which rate is based
L = the value in Table C that corresponds to the number B, using the 96 percent CI column
U = the value in Table C that corresponds to the number B, using the 96 percent CI column
f = the factor which depends on whether an entire or a sampled population (like one from a Current Population Survey – CPS) is used, and the span of years represented. f equals 0.670 for a single year
a and b are CPS standard error parameters (see previous section on 95-percent confidence interval for 100 or more births for description and specific values)
P = total estimated population upon which the rate is based

NOTE: In the formulas above, the confidence limits are estimated from the non-sampling error in the number of births, the numerator, and the sampling error in the population estimate, the denominator. A 96 percent standard error is computed for the numerator and a 99 percent standard error is computed for the denominator in order to compute a 95-percent confidence interval for the rate**.**

<u>Example</u>

Suppose that the birth rate of Puerto Rican women 45–49 years of age was 0.4 per 1,000, based on 35 births in the numerator and an estimated resident population of 87,892 in the denominator. Using Table C, the 95-percent confidence interval would be:

$$\text{Lower limit} = 0.4 * 0.68419 * \left(1 - 2.576\sqrt{0.670\left(-0.000096 + \left(\frac{3{,}809}{87{,}892}\right)\right)}\right)$$
$$= 0.4 * 0.68419 * \left(1 - 2.576\sqrt{0.028972}\right)$$
$$= 0.4 * 0.68419 * \left(1 - (2.576 * 0.170211)\right)$$
$$= 0.4 * 0.68419 * 0.561536$$
$$= 0.154$$

$$\text{Upper limit} = 0.4 * 1.41047 * \left(1 + 2.576\sqrt{0.670\left(-0.000096 + \left(\frac{3{,}809}{87{,}892}\right)\right)}\right)$$
$$= 0.4 * 1.41047 * \left(1 + 2.576\sqrt{0.028972}\right)$$
$$= 0.4 * 1.41047 * \left(1 + (2.576 * 0.170211)\right)$$
$$= 0.4 * 1.41047 * 1.438464$$
$$= 0.812$$

This means that the chances are 95 out of 100 that the actual birth rate of Puerto Rican women 45–49 years of age lies between 0.15 and 0.81.

Significance testing for subgroups—When both rates are based on 100 or more events, the difference between the two rates is considered statistically significant if it exceeds the value given by the formula below. This statistic equals 1.96 times the standard error for the difference between two rates.

$$z = 1.96 * \sqrt{R_1^2 * \left[\left(\frac{1}{B_1}\right) + f\left(a + \frac{b}{P_1}\right)\right] + R_2^2 * \left[\left(\frac{1}{B_2}\right) + f\left(a + \frac{b}{P_2}\right)\right]}$$

If the difference is greater than this statistic, then the difference would occur by chance less than 5 times out of 100. If the difference is less than this statistic, the difference might occur by chance more than 5 times out of 100. We would therefore conclude that the difference is not statistically significant at the 95-percent confidence level.

Example

Suppose the birth rate for Mexican mothers 15–19 years of age (R_1) is 94.5, based on 97,744 births and an estimated population of 1,033,878, and the birth rate for Puerto Rican mothers 15–19 years of age (R_2) is 61.4, based on 10,006 births and an estimated population of 162,899. Using the above formula, the z score is computed as follows:

$$
\begin{aligned}
&= 1.96 * \sqrt{94.5^2 * \left[\left(\frac{1}{97,744}\right) + 0.670\left(-0.000096 + \frac{3,809}{1,033,878}\right)\right] + 61.4^2 * \left[\left(\frac{1}{10,006}\right) + 0.670\left(-0.000096 + \frac{3,809}{162,899}\right)\right]} \\
&= 1.96 * \sqrt{8930.25 * (0.000010231 + 0.670 * 0.003589) + 3769.96(0.00009994 + 0.670 * 0.023287)} \\
&= 1.96 * \sqrt{(8930.25 * 0.0024147) + (3769.96 * 0.015702)} \\
&= 1.96 * \sqrt{21.563 + 59.20} \\
&= 1.96 * 8.99 \\
&= 17.61
\end{aligned}
$$

Since the difference between the two rates 33.1 is greater than the value above, the two rates are statistically significantly different at the 0.05 level of significance.

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